JOB IV. JUVENILE PRODUCTION ASSESSMENT

Objectives:

To determine the relative annual abundance and distribution of alosine juveniles in the Patuxent River. To determine nursery areas for alewife and blueback herring in these drainage systems.

A. Methods and procedures:

Nursery area sampling was conducted in the Patuxent River drainage on a bi-weekly basis from July through September in 1980, 1981, and 1982. Ten stations were sampled (Figures 50 through 52) in 1980, eight stations in 1981, and six stations in 1982. Stations were reduced from year to year, attributed to the lack of catch or a greatly reduced catch at lower sampling sites which could have been caused by relatively high salinity.

Samples were contained with a push net (push trawl), 1.5 m X 1.5 m (5 ft. X 5 ft.), mounted on the bow of a boat utilizing a steel frame (Kriete and Loesch, 1980). The trawl (push net) is a replicate to the push net developed by VIMS personnel and employed in Virginia's waters, (Figure 53). Only surface samples were obtained with the push net. The stretched mesh in the body was 3/4 inch (18 mm) and 1/2 inch (12 mm) in the cod end.

All sampling was performed during the nighttime. A General Oceanics model 2030-R flowmeter was fitted into the face of the net to determine the average velocity at which each trawl was made. The area swept by this gear was calculated as:

$$\frac{1.524\text{m}^* \times \text{Trawl run length (m)}}{10{,}000\ \text{M}^2} = \text{area swept in hectares}$$

The area swept by this gear along with the number of trawl runs completed by site and sampling area are presented in Tables 33 through 35.

*1.524 m = Trawl mouth opening.

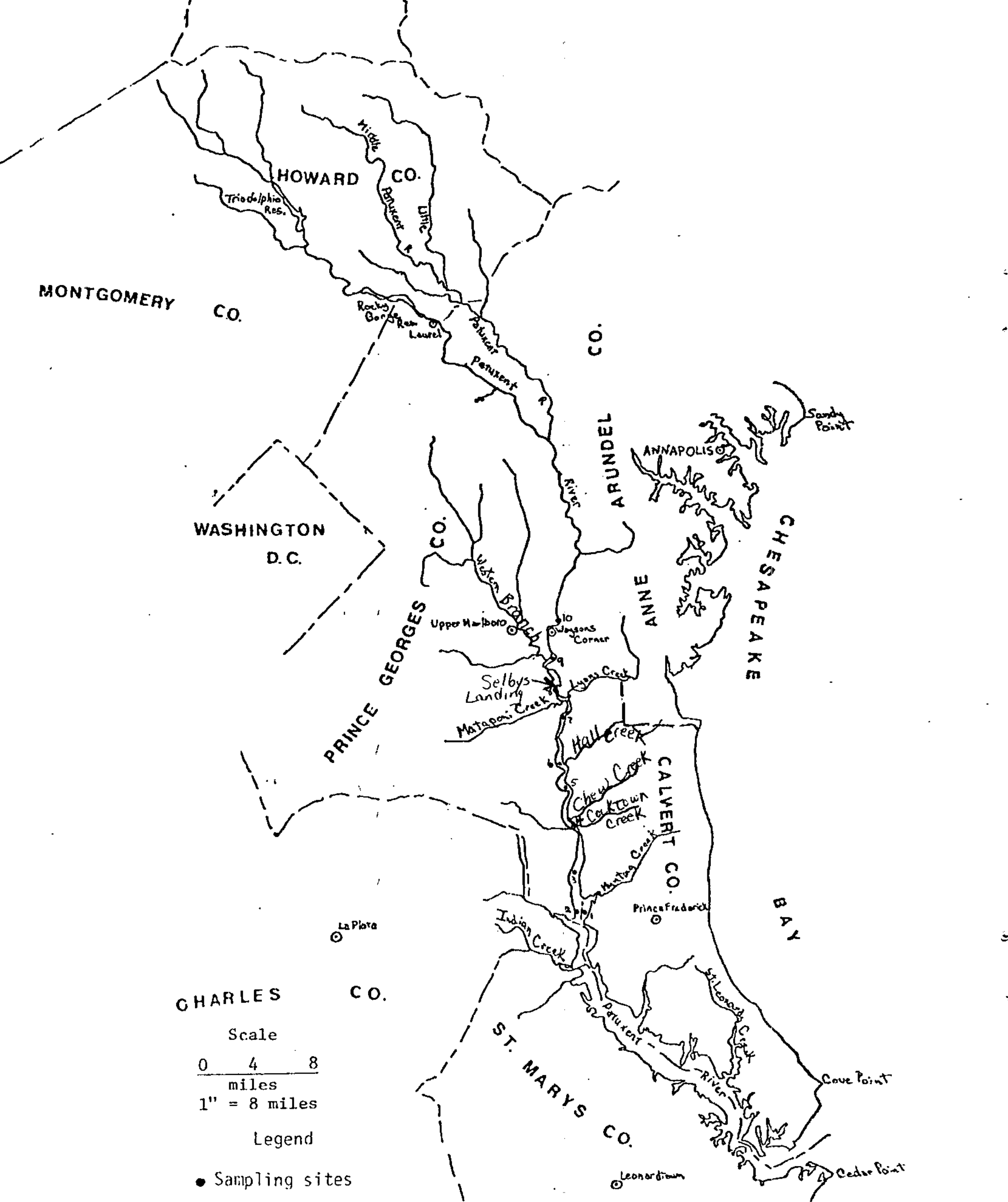


Figure 50. Location of Patuxent River drainage push trawl sampling sites during the 1980 study period.

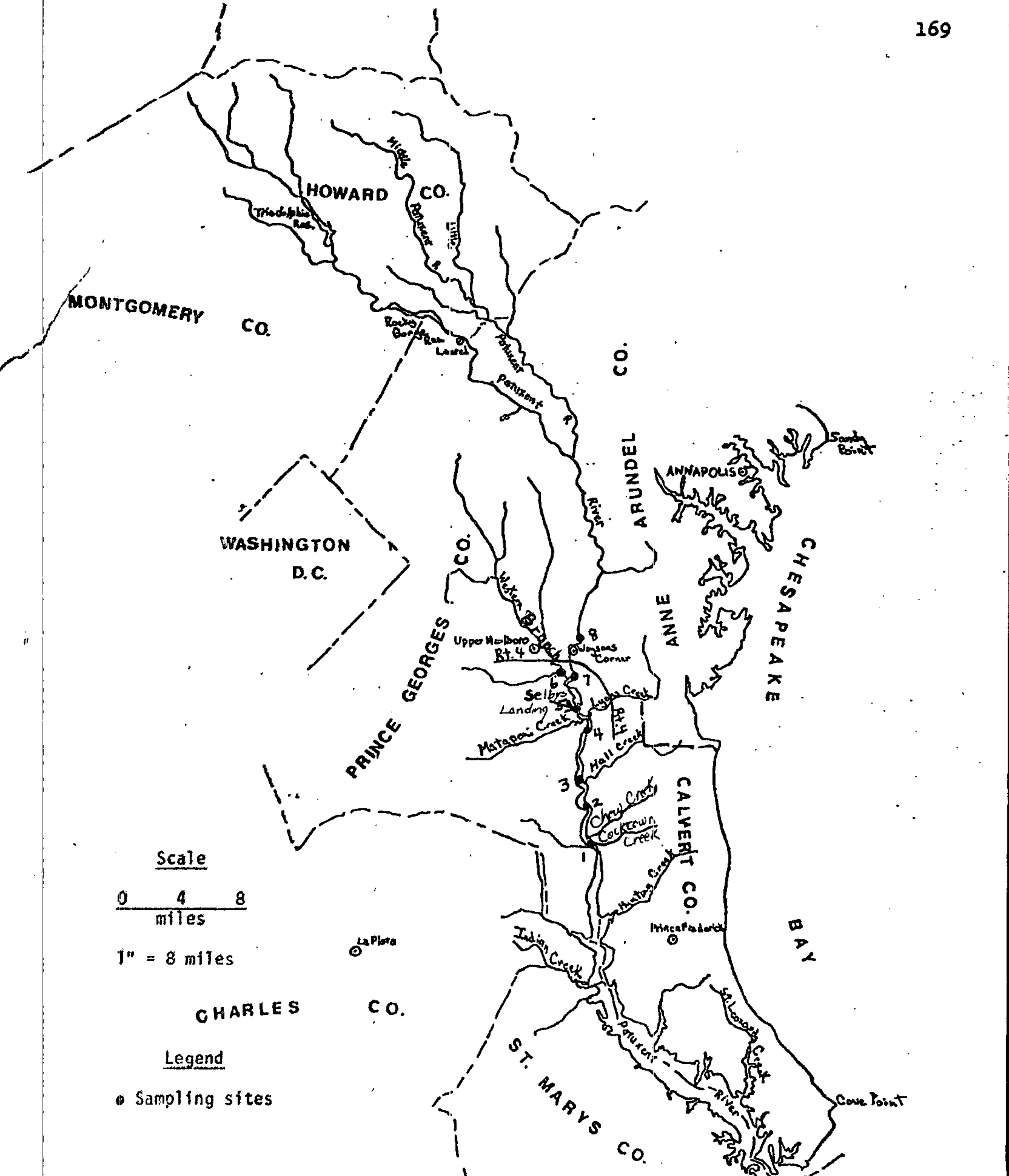
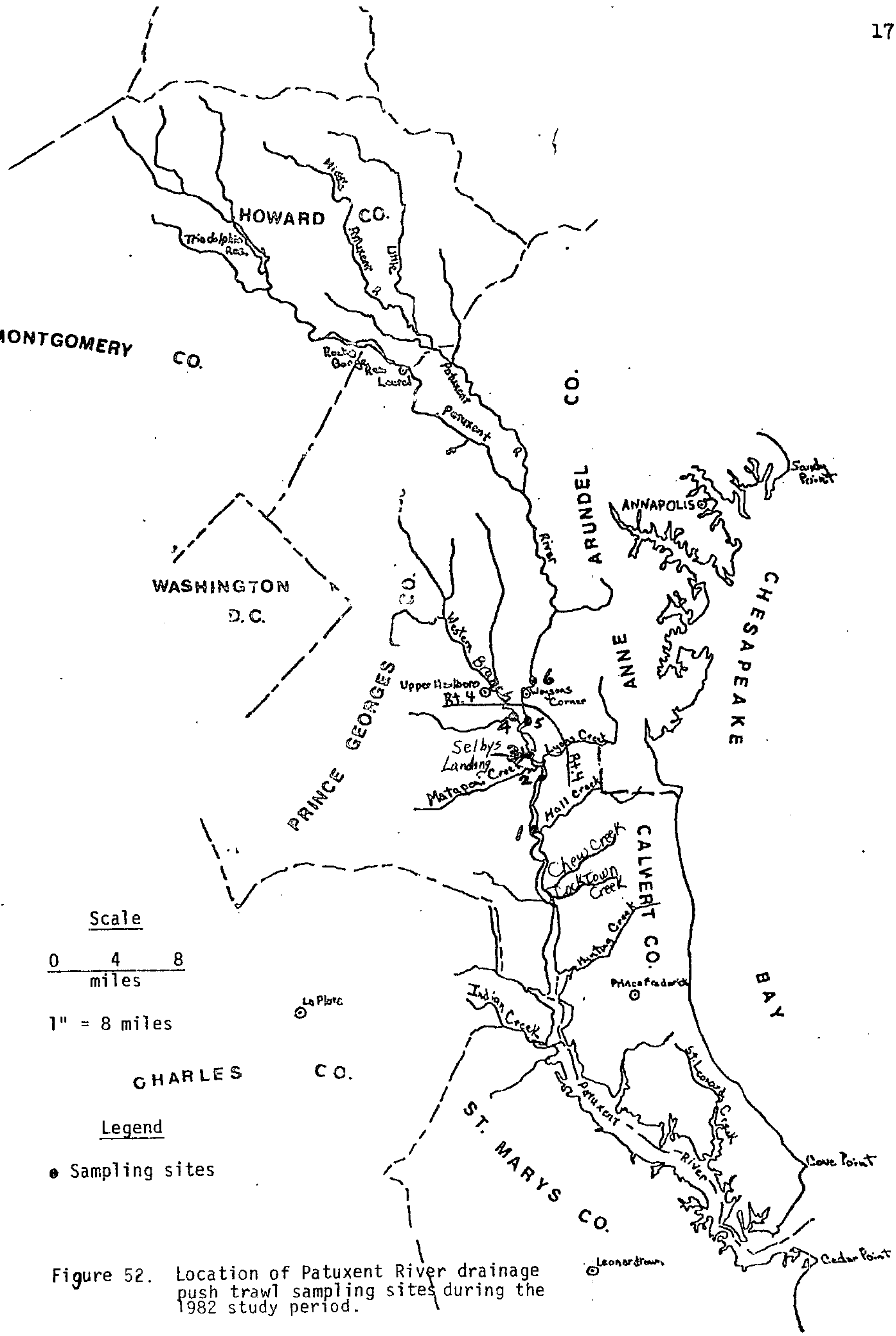


Figure 51. Location of Patuxent River drainage push trawl sampling sites during the 1981 study period.



Scale

0 4 8

miles

1" = 8 miles

Legend

• Sampling sites

Figure 52. Location of Patuxent River drainage push trawl sampling sites during the 1982 study period.

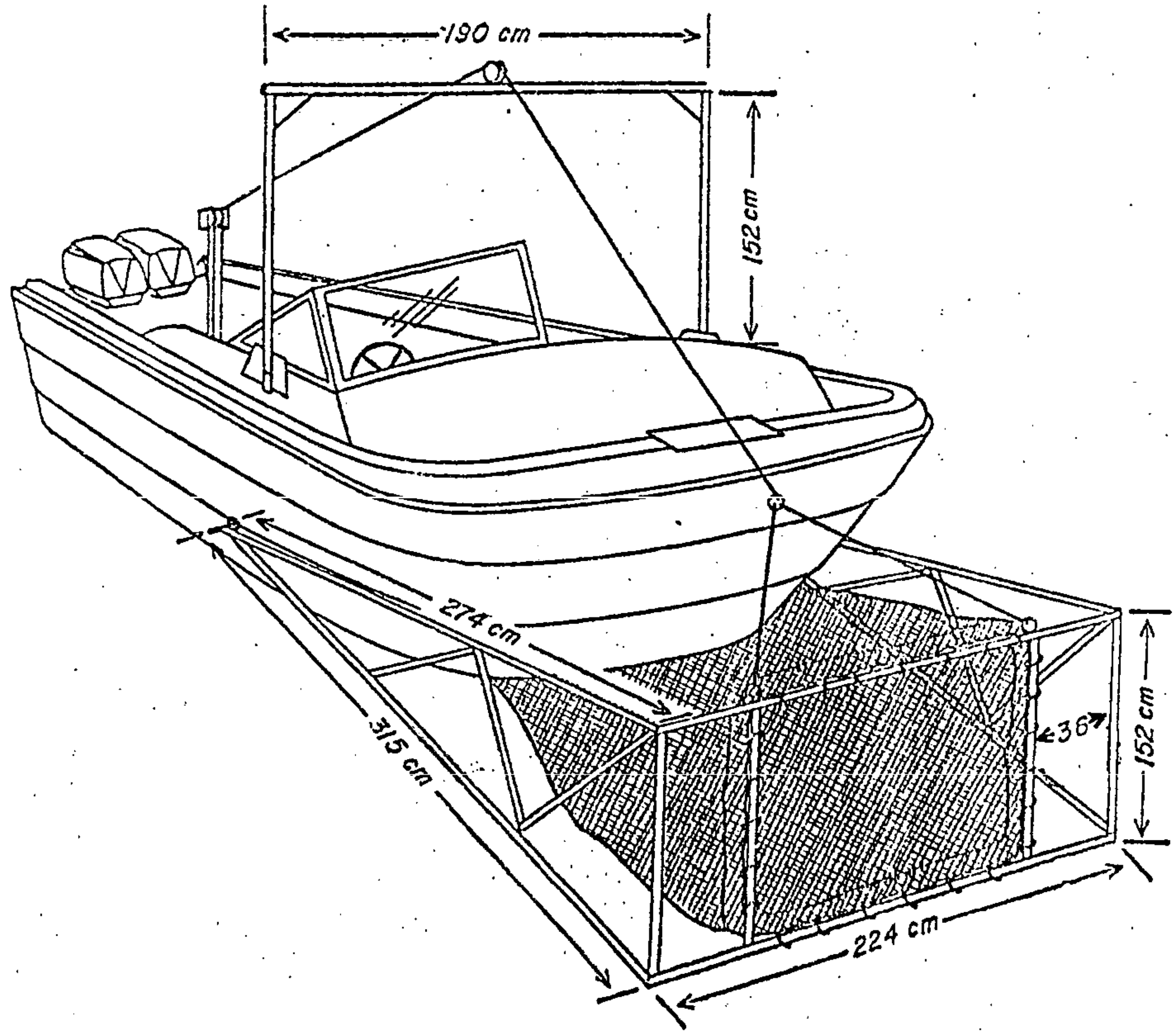


Figure 53. Schematic diagram of push net.

Table 33. Area swept by push trawl, number of trawls completed, and total area swept by site during the 1980 Juvenile Recruitment Survey in the Patuxent River drainage.

Site No.	No. of Hauls	Area Swept (ha.)	Total Area Swept (ha.)
1	4	.0687	0.2748
2	4	.0610	0.2440
3	4	.0546	0.2184
4	4	.0579	0.2316
5	4	.0520	0.2080
6	4	.0544	0.2176
7	4	.0541	0.2164
8	4	.0553	0.2212
9	4	.0565	0.2260
10	4	.0680	0.2720
		TOTAL:	2.3300

Table 34. Area swept by push trawl, number of trawl runs completed, and total area swept by site during the 1981 Juvenile Recruitment Survey in the Patuxent River drainage.

Site No.	No. of Hauls	Area Swept (ha.)	Total Area Swept (ha.)
1	2	.0520	0.1040
2	2	.0463	0.0926
3	7	.0450	0.3150
4	7	.0453	0.3171
5	7	.0462	0.3234
6	7	.0461	0.3227
7	7	.0483	0.3381
8	7	.0490	0.3430
		TOTAL:	2.1559

TABLE 35. Area swept by push trawl, number of trawl runs completed, and total area swept by site during the 1982 Juvenile Recruitment Survey in the Patuxent River drainage.

Site No.	No. of Hauls	Area Swept (ha.)	Total Area Swept (ha.)
1	7	.0490	0.3430
2	7	.0436	0.3052
3	7	.0484	0.3388
4	7	.0485	0.3394
5	7	.0514	0.3596
6	7	.0489	0.3423
		TOTAL:	2.0283

Anadromous fish collected were identified, counted, measured (fork length in mm) and weighed (g). Species other than anadromous fishes were also counted, measured (fork length in mm), and weighed (g) by species. Environmental parameters including water temperature, salinity, depth and bottom type at each sample station, were recorded.

Stations were sampled for five minutes at 1200 or 1400 revolutions per minute (rpm), depending on the tide, with a 19 foot boat equipped with two 70 horsepower outboard engines. The trawl was fished in both directions of tidal movement. When the trawl was fished against the tide, both engines were operating at 1200 rpm; however, fishing the trawl with the tide, they were increased to 1400 rpm. This was done to standardize the volume of water passing through the trawl at a two knot speed. Thus, the push trawl could be fished at a predetermined rpm for a predetermined time (five minutes). According to VIMS personnel, the tide had no effect on the catch data with this trawl. Trawl distance and volume of water strained through the push net (flowmeter readings) were recorded.

All the sample stations in the Patuxent River drainage were established in the midwater areas of the river in water deeper than 1.8 m (6 ft.) depth (MLW) indicated on the respective navigation charts. All river stations were sampled at the lower summer nursery area in the river near the confluence of Chew Creek and Cocktown Creek (river mile 32.6), which was the lower limit of the first river herring catch. The upper summer nursery area was located at the farthest upriver sampling site (above Rt. 4) (river mile 48.6) which could be feasibly sampled with this gear (Figure 54). The nursery area may have extended farther up the river than sampled.

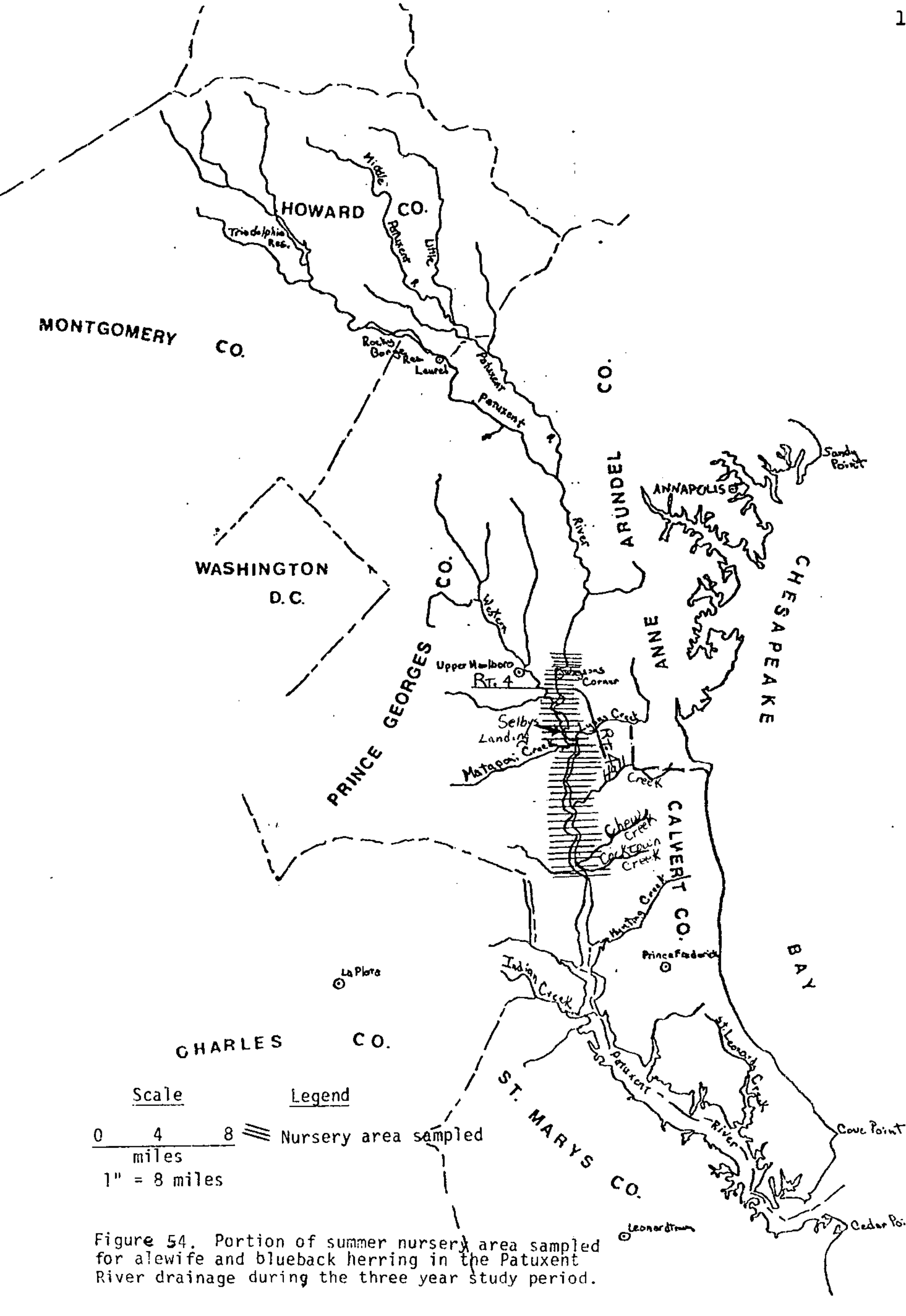


Figure 54. Portion of summer nursery area sampled for alewife and blueback herring in the Patuxent River drainage during the three year study period.

Generally, all sample locations in the study area were within the oligohaline ecological zone (fresh water to less than 5 ppt. salinity). After completion of the surveys, juvenile catch data were examined by species for density patterns within that portion of the nursery area sampled and estimates of catch-per-unit-of-effort (CPUE) were made.

The annual index of abundance is the catch-per-unit-of-effort (CPUE) derived from any necessary data adjustments for catch efficiency. One trawl haul was considered as one unit of effort.

B. Results and discussions:

1. Relative abundance:

The sampling objective of the study was to determine the relative abundance (CPUE) of herring in the Patuxent River, as an indice of successful reproduction of the 1980, 1981, and 1982 year classes. Comparison of the data showed changes in juvenile abundance between year classes. Hopefully, this data when compiled over a sufficient length of time and combined with data on year class composition of spawning adults will enable prediction of harvestable adult populations prior to the fishing season. This type of relationship may exist as suggested by Havey's (1973) work with alewife in Maine. His study found a linear relationship between the number of juveniles leaving the nursery area in the fall and the number of adults entering the spawning grounds four years later.

Number of samples and abundance for each year class of *A. aestivalis* (blueback herring) and *A. pseudoharengus* (alewife herring) for the Patuxent River are shown in Tables 36 through 38. The CPUE data for each herring species by month are shown in Figures 55 through 57. It was apparent that the 1982 year class for each species was considerably larger than the 1980

Table 36. Numbers caught and catch-per-unit-effort (CPUE*) by sampling site for young-of-year *Alosa aestivalis* and *Alosa pseudoharengus* with a push trawl during the 1980 Juvenile Recruitment Survey in the Patuxent River drainage.

Site No.	Species	Catch	Effort (No. of Tows)	CPUE	Mean Distance in Meters	Mean Volume Filtered M^3
1	No anadromous fish collected		4	0	450.53	1013.69
2	No anadromous fish collected		4	0	400.15	900.35
3	No anadromous fish collected		4	0	358.04	805.60
4	*Alosa pseudoharengus*	1	4	.3	379.76	854.45
5	No anadromous fish collected		4	0	340.93	767.10
6	*Alosa aestivalis*	2	4	.5	356.95	803.13
7	*A. aestivalis*	1	4	.3	354.80	798.31
8	*A. aestivalis*	1	4	.3	362.81	816.31
9	*A. aestivalis* *A. pseudoharengus*	8 4	4	2.0 1.0	370.42	833.45
10	*A. aestivalis* *A. pseudoharengus*	170 21	4	42.5 5.3	446.21	1003.97
Yearly Abundance:	*A. aestivalis* *A. pseudoharengus*	182 26	40	4.55 .65	382.06	799.81

* CPUE: Total number of a species/total number of hauls sampled.

Table 37. Numbers caught and catch-per-unit-effort (CPUE*) by sampling site for young-of-year *Alosa aestivalis* and *Alosa pseudoharengus* with a push trawl during the 1981 Juvenile Recruitment Survey in the Patuxent River drainage.

Site No.	Species	Catch	Effort (No. of Tows)	CPUE	Mean Distance in Meters	Mean Volume Filtered M^3
1	No anadromous fish collected		2	0	341.33	767.99
2	*Alosa pseudoharengus*	1	2	0.5	304.01	684.03
3	No anadromous fish collected		7	0	295.48	664.83
4	*Alosa pseudoharengus*	1	7	0.1	297.45	669.27
5.	*Alosa aestivalis*	2	7	0.3	302.83	681.38
	A. pseudoharengus	4		0.6		
6	*A. aestivalis*	1	7	0.1	302.62	680.89
	A. pseudoharengus	6		0.9		
7	*A. aestivalis*	10	7	1.4	316.76	712.70
	A. pseudoharengus	4		0.6		
8	*A. aestivalis*	65	7	18.6	301.17	677.63
	A. pseudoharengus	28		4.0		
Yearly Abundance:	*A. aestivalis*	78	46	1.70	307.71	692.34
	A. pseudoharengus	44		1.00		

*CPUE: Total number of a species/total number of hauls sampled.

Table 38. Numbers caught and catch-per-unit-effort (CPUE*) by sampling site for young-of-year *Alosa aestivalis* and *Alosa pseudoharengus* with a push trawl during the 1982 Juvenile Recruitment Survey in the Patuxent River drainage.

Site No.	Species	Catch	Effort (No. of Tows)	CPUE	Mean Distance in Meters	Mean Volume Filtered M^3
1	*Alosa aestivalis*	3	7	0.43	321.46	723.29
	Alosa pseudoharengus	132		18.86		
2	*A. pseudoharengus*	161	7	23.0	285.99	643.48
3	*A. aestivalis*	57	7	8.1	317.82	715.10
	A. pseudoharengus	125		17.9		
4	*A. aestivalis*	2310	7	330.0	318.11	715.75
	A. pseudoharengus	1321		188.7		
5	*A. aestivalis*	1152	7	164.6	337.04	758.34
	A. pseudoharengus	661		94.4		
6	*A. aestivalis*	1129	7	161.3	320.75	721.69
	A. pseudoharengus	31		4.4		
Yearly Abundance:	*A. aestivalis*	4651	42	110.7	316.86	712.94
	A. pseudoharengus	2431		57.8		

*CPUE: Total number of a species/total number of hauls sampled.

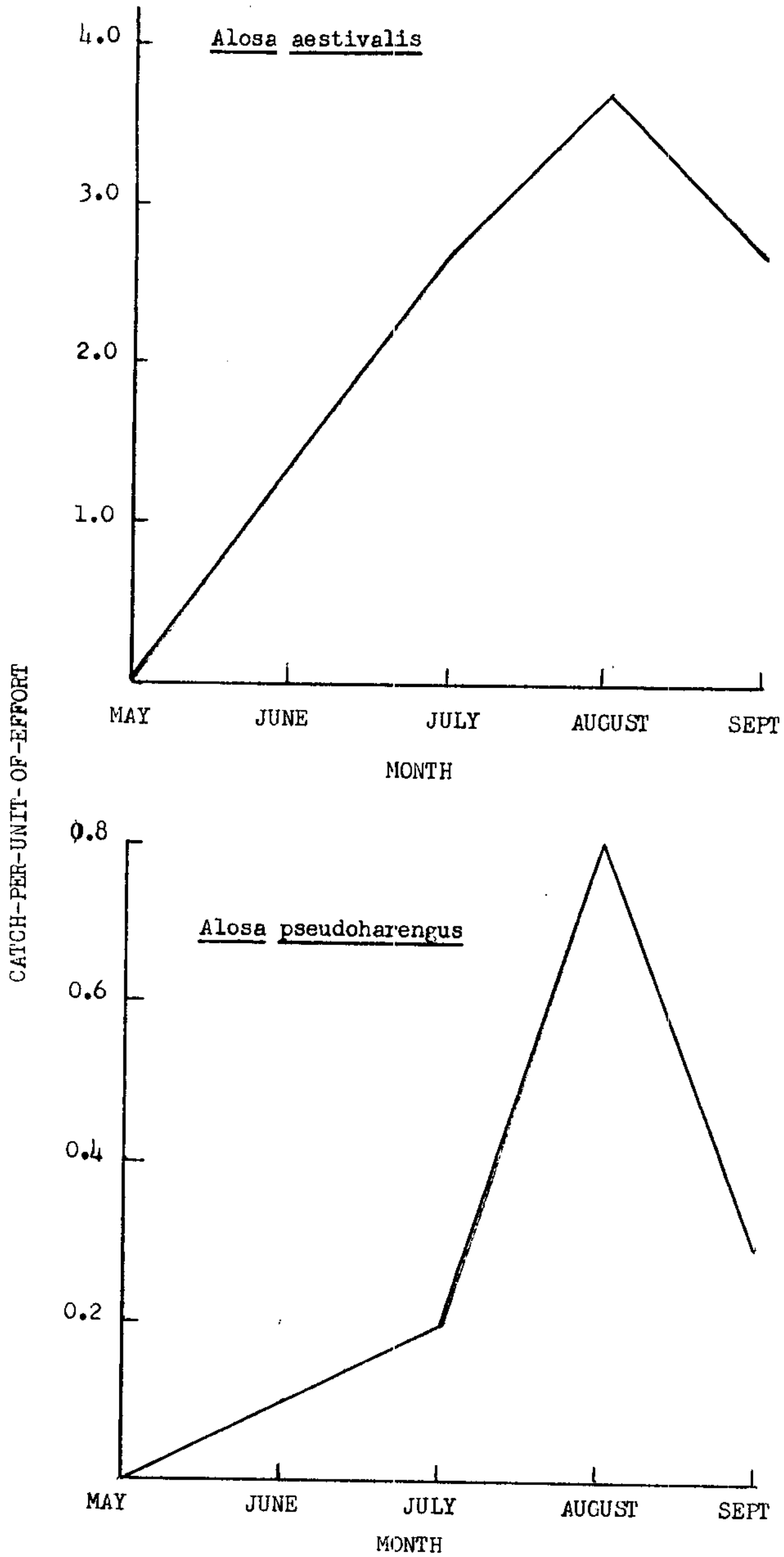


Figure 55. Monthly catch-per-unit-effort, 1980 year class of A. aestivalis and A. pseudoharengus in the Patuxent River.

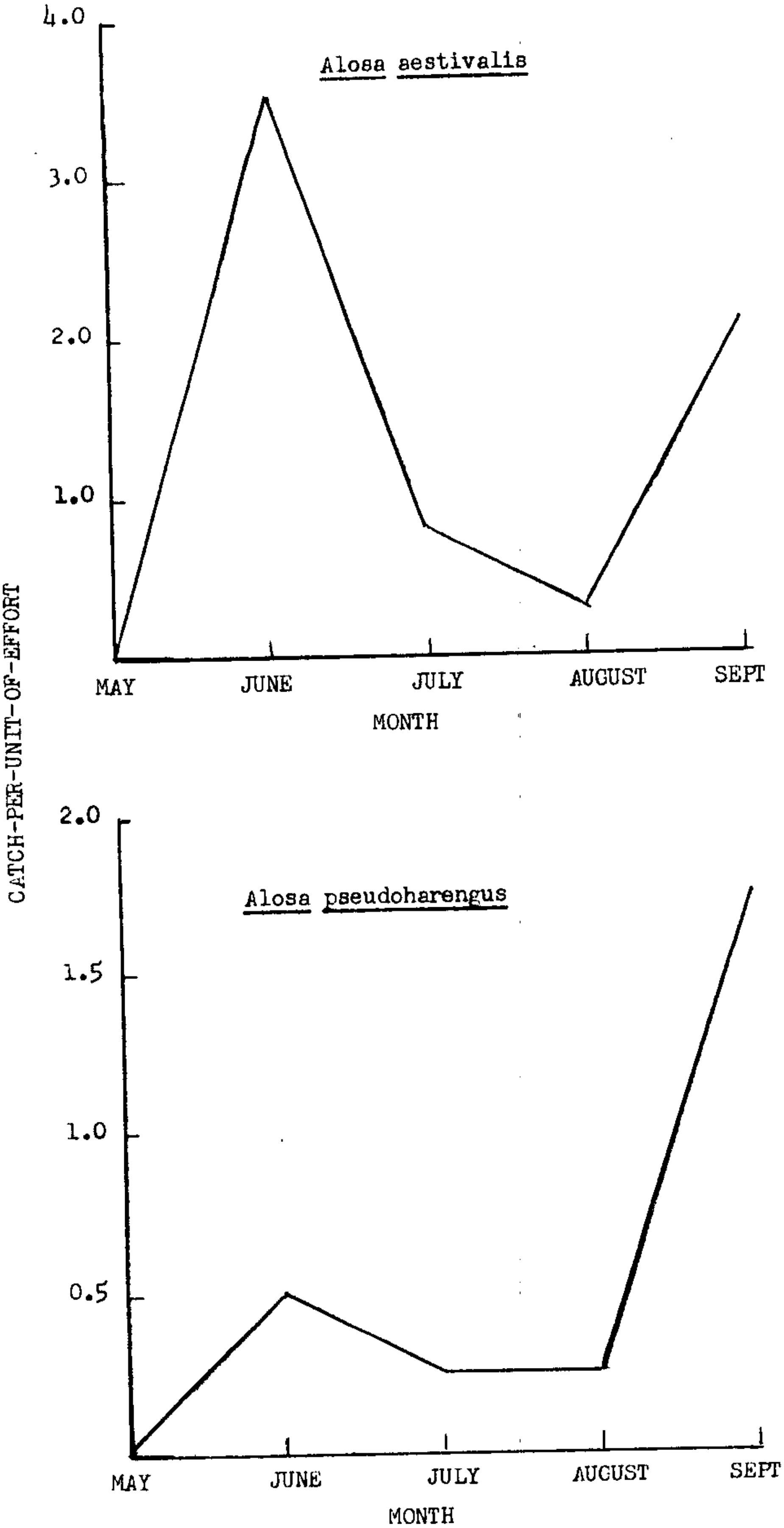


Figure 56. Monthly catch-per-unit-effort, 1981 year class of *A. aestivalis* and *A. pseudoharengus* in the Patuxent River.

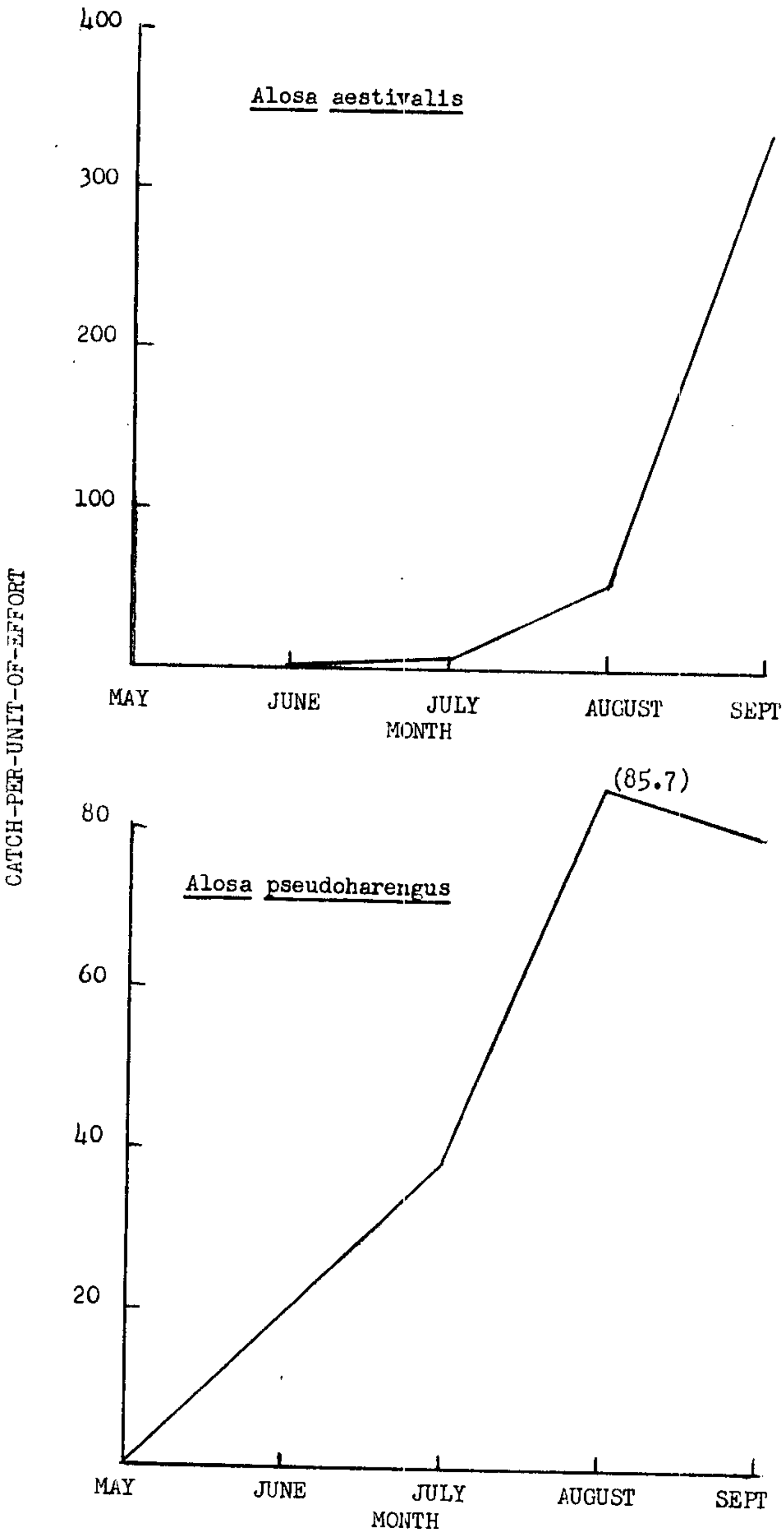


Figure 57. Monthly catch-per-unit-effort, 1982 year class of A. aestivalis and A. pseudoharengus in the Patuxent River.

and 1981 year classes. The overall CPUE for both species of river herring in the sampling area was 58.69 fish per haul for the three year study. Blueback herring CPUE figure in 1980 was 4.55 fish per haul; however, there was a considerable decline in the 1981 CPUE figure (1.70 fish per haul) for this species (Tables 36 and 37). This was probably due to the further decline in the adult stocks of blueback herring species as shown in Table 39.

The 1980 Patuxent River figure for alewife was .65 fish per haul which was very similar to the CPUE figure for 1981 (1.0 fish per haul). This data also reflects this downward trend in adult stocks as shown in Table 39.

In 1982, however, both alewife and blueback herring showed a strong year class (Table 38) with a CPUE index of 57.8 alewife and 110.7 blueback juveniles per haul. This reversed the decline for each species and could be considered a record year class. Alewife recovered from a 1980 index of .65 to 57.8 juveniles per haul in 1982. Blueback herring showed a dramatic recovery from a 1980 index of 4.55 juveniles per haul to 110.7 juveniles per haul in 1982. This high level of juvenile abundance for each herring species in 1982 will probably affect adult availability in three to four years as they return to spawn for the first time.

Even though there was a substantial increase in CPUE figures for each species in 1982, the commercial landings for the Patuxent River reflected a very small adult population of river herring (Table 39). As previously mentioned earlier in this report, the herring catch as reported by the licensed fishermen's reports to the statistical section of the Tidewater Administration was only 142 pounds for 1982. This record was probably invalid since the pound netters as well as the majority of the gill netters

Table 39. Maryland commercial lardings - Patuxent River, statistical areas 168 and 268.

YEAR	HERRING CATCH (lbs.)
1962	12,071
1963	8,045
1964	8,671
1965	5,630
1966	3,763
1967	3,735
1968	4,893
1969	16,005
1970	23,498
1971	21,406
1972	21,058
1973	16,371
1974	6,647
1975	13,228
1976	3,506
1977	1,471
1978	3,010
1979	2,378
1980	2,403
1981	2,398
1982	142

did not report their herring catch. Thus, it can only be assumed that there was a large spawning run of the adults as indicated by the CPUE figures for 1982.

Based on the findings of the three year study, the blueback herring CPUE greatly exceeded those for alewives (Tables 36 through 38). In each year, the dominant Alosa species in the samples was the blueback herring. According to Loesch et al 1979, blueback herring CPUE also greatly exceeded those for alewives in six rivers sampled, which are located in Virginia. In that year, blueback herring CPUE reached a maximum in July or early August, then declined. In contrast, alewife CPUE were generally greatest in June or early July and juveniles were more widely distributed in June and early July, had greater upriver concentrations in the summer, and then moved downward in September and October as a first stage of their seaward migration. The greater abundance of blueback herring CPUE could be due, in part, to the Alosa phototropic behavior (Loesch et al 1980); however, commercial landings indicate that blueback herring are more abundant than alewives. Differences in the time of maximal CPUE stem from the differences in time when the bulk of each species spawns. Changes in the distribution of juveniles probably reflect hydrological changes; apparently, juveniles move upriver in the summer because of lessening of fresh water runoff and ensuing encroachment of saline water (Loesch and Kriete, 1980).

Based on the findings from the Patuxent River study, the distribution pattern for both blueback and alewife herring CPUE reached a maximum in August and September (Figures 55 through 57). This distribution pattern was not similar to the Loesch et al, 1979 study (see discussion above). Data from the Patuxent River study did show a downriver migration, since each species reached their maximum CPUE in September, which was probably a reflection of their seaward migration. The largest CPUE occurred at the farthest upriver sampling sites where the salinities were the lowest, ranging from less than .10 to .28 ppt. These sites were located in Western Branch, tributary to the Patuxent River, and the Patuxent River at 0.1 mile upriver from the confluence of Western Branch, and another site located immediately above Rt. 4 road crossing near Waysons Corner, Maryland.

2. Standing crop:

Altogether 41,641 fish were captured by the push trawl from the sampling area in 128 hauls, from which there were 34 species (Table 40). Summary estimates of density numbers, weights, and standing crop (number /hectare) of all species collected by this gear for each year sampled are presented in Table 41 through 43. The figures in the Tables are presented for both numerical density and weight density. The units are in the metric system 1/. Numerical densities were rounded to the nearest whole number. In general, the estimates are for the standing crop of juvenile and older fish which are resident in the nursery area from June through November.

Standing crop estimates greatly increased in 1982 for each river herring species relative to 1980 and 1981. The push trawl used seemed to be selective to some degree for the Clupeidae species. These species included the anadromous genus *Alosa* (*A. aestivalis* and *A. pseudoharengus*), as well as the highly abundant *Anchoa mitchilli* (bay anchovy) and *Brevoortia tyrannus* (Atlantic menhaden). This could be due to the apparent tendency of these species to inhabit shallow or surface water and mid-water river areas. Street et al, (1975) and Johnson et al, (1977) inferred that

1/ To convert from the metric system to English: For numbers, divide number per hectare by 2.471 to yield number per acre, and for weight multiply kilograms per hectare by 0.892 to yield pounds per acre.

Table 40. Species caught during the 1980, 1981, and 1982 Juvenile Recruitment Surveys in the Patuxent River drainage.

	Scientific Name	Common Name
1	Alosa aestivalis	Blueback herring
2	Alosa pseudoharengus	Alewife herring
3	Anchoa mitchilli	Bay Anchovy
4	Anguilla rostrata	American eel
5	Brevoortia tyrannus	Atlantic menhaden
6	Caranx hippos	Jack; Crevalle
7	Catostomus commersoni	White sucker
8	Cynoscion regalis	Weakfish
9	Dorosoma cepedianum	Gizzard shad
10	Fundulus diaphanus	Banded killfish
11	Fundulus heteroclitus	Mummichog
12	Hybognathus nuchalis	Silvery minnow
13	Ictalurus catus	White catfish
14	Ictalurus nebulosus	Brown bullhead
15	Ictalurus punctatus	Channel catfish
16	Leiostomus xanthurus	Spot
17	Lepomis gibbosus	Pumpkinseed
18	Lepomis macrochirus	Bluegill
19	Membras martinica	Rough silverside
20	Menidia beryllina	Tidewater silverside
21	Menidia menidia	Atlantic silverside
22	Morone americana	White perch
23	Morone chrysops	Hybrid (striped bass x white bass)
24	Morone saxatilis	Striped bass
25	Notemigonus crysoleucas	Golden shiner
26	Notropis hudsonius	Spottail shiner
27	Peprilus alepidotus	Harvestfish; Butterfish
28	Perca flavescens	Yellow perch
29	Pomatomus saltatrix	Bluefish
30	Pomoxis annularis	White crappie
31	Pomoxis nigromaculatus	Black crappie
32	Strongylura marina	Atlantic needlefish
33	Trinectes maculatus	Hogchoker

34. **Etheostoma olmstedi**, Tessellated Johnny darter, also collected

Table 41. Summary estimates of total number collected, total area swept, and standing crop in numbers and weights per hectare and per acre for all species as sampled by push trawl during the 1980 Juvenile Recruitment Survey in the Patuxent River drainage.

	NUMERICAL				WEIGHT			
Species	Sample Size	Total Area Swept (hectare)	Mean No./ hectare	Mean No./ acre	Kg.	lb.	Kg. per hectare	lb. per hectare
Alosa aestivalis	182	2.3300	78.11	31.61	0.247	0.545	0.106	0.095
Alosa pseudoharengus	26		11.16	4.52	0.132	0.291	0.057	0.051
Anchoa mitchilli	4240		1819.74	736.44	4.271	9.423	1.833	1.635
Anguilla rostrata	2		0.86	0.35	0.188	0.415	0.081	0.072
Brevoortia tyrannus	10078		4235.32	1750.43	115.438	254.685	49.544	44.193
Cynoscion regalis	92		39.49	15.98	0.412	0.909	0.177	0.158
Caranx hippos	1		0.43	0.17	0.003	0.007	0.001	0.001
Dorosoma cepedianum	48		20.60	8.34	0.368	0.812	0.158	0.141
Hybognathus nuchalis	10		4.29	1.74	0.018	0.040	0.008	0.007
Ictalurus catus	10		4.29	1.74	0.805	1.776	0.346	0.308
Ictalurus punctatus	40		17.17	6.95	0.972	2.145	0.417	0.372
Membras martinica	36		15.45	6.25	0.071	0.157	0.031	0.027
Menidia beryllina	20		8.58	3.47	0.040	0.088	0.017	0.015
Menidia menidia	5		2.15	1.91	0.014	0.031	0.006	0.005
Morone americana	8		3.43	1.39	0.731	1.613	0.314	0.280
Notropis hudsonius	21		9.01	3.65	0.024	0.053	0.010	0.009

Table 41. Summary estimates for 1980 Juvenile Recruitment Survey (Cont'd).

	NUMERICAL				WEIGHT			
Species	Sample Size	Total Area Swept (hectare)	Mean No./ hectare	Mean No./ acre	Kg.	lb.	Kg. per hectare	lb. per hectare
Peprilus alepidotus	7	2.3300	3.00	1.22	0.210	0.463	0.090	0.080
Pomatomus saltatrix	10		4.29	1.74	0.783	1.728	0.336	0.300
Strongylura marina	1		0.43	0.17	0.078	0.172	0.034	0.030
Trinectes maculatus	7		3.00	1.22	0.078	0.172	0.034	0.030
TOTALS	14844	2.3300	6370.82	2579.29	124.883	275.525	53.599	47.809

Table 42. Summary estimates of total number collected, total area swept, and standing crop in numbers and weights per hectare and per acre for all species as sampled by push trawl during the 1981 Juvenile Recruitment Survey in the Patuxent River drainage.

	NUMERICAL				WEIGHT			
Species	Sample Size	Total Area Swept (hectare)	Mean No./ hectare	Mean No./ acre	Kg.	lb.	Kg. per hectare	lb. per hectare
Alosa aestivalis	78	2.1559	36.18	14.64	0.139	0.307	0.065	0.058
Alosa pseudoharengus	44		20.41	8.26	0.265	0.585	0.123	0.110
Anchoa mitchilli	3531		1637.83	662.82	5.209	11.492	2.416	2.155
Anguilla rostrata	22		10.21	4.13	0.577	1.273	0.268	0.239
Brevoortia tyrannus	2729		1265.83	512.27	24.312	53.638	11.277	10.059
Catostomus commersoni	1		0.46	0.19	0.036	0.079	0.017	0.015
Cynoscion regalis	21		9.74	3.94	0.132	0.291	0.061	0.055
Dorosoma cepedianum	48		22.27	9.01	0.045	0.099	0.021	0.019
Etheostoma olmstedi	2		0.93	0.38	0.007	0.015	0.003	0.003
Fundulus diaphanus	5		2.32	2.07	0.009	0.019	0.004	0.004
Hybognathus nuchalis	84		38.96	15.77	0.475	1.048	0.220	0.197
Ictalurus catus	10		4.64	1.88	1.101	2.429	0.511	0.456
Ictalurus punctatus	18		8.35	3.38	0.892	1.968	0.414	0.369
Leiostomus xanthurus	54		25.05	10.14	1.408	3.106	0.653	0.583
Lepomis macrochirus	1		0.46	0.19	0.008	0.017	0.004	0.003
Membras martinica	38		17.63	7.13	0.118	0.260	0.055	0.049

Table 42. Summary estimate for 1981 Juvenile Recruitment Survey (Cont'd).

	NUMERICAL				WEIGHT			
Species	Sample Size	Total Area Swept (hectare)	Mean No./ hectare	Mean No./ acre	Kg.	lb.	Kg. per hectare	lb. per hectare
Menidia beryllina	6861	2.1559	3182.43	1287.91	18.772	41.416	8.707	7.767
Menidia menidia	46		21.34	8.64	0.093	0.205	0.043	.039
Morone americana	46		21.34	8.64	2.768	6.107	1.284	1.145
Notropis hudsonius	193		89.52	36.23	1.214	2.678	0.563	0.502
Pomatomus saltatrix	1		0.46	0.19	0.010	0.022	0.005	0.004
Pomoxis nigromaculatus	1		0.46	0.19	0.078	0.172	0.036	0.032
Trinectes maculatus	51		23.66	9.57	0.305	0.673	0.142	0.126
TOTALS	13885	2.1559	6440.48	2607.57	57.973	127.899	26.892	23.989

Table 43. Summary estimates of total number collected, total area swept, and standing crop in numbers and weights per hectare and per acre for all species as sampled by push trawl during the 1982 Juvenile Recruitment Survey in the Patuxent River drainage.

	NUMERICAL				WEIGHT			
Species	Sample Size	Total Area Swept (hectare)	Mean No./ hectare	Mean No./ acre	Kg.	lb.	Kg. per hectare	lb. per hectare
Alosa aestivalis	4651	2.0283	2,293.05	927.99	5.434	11.989	2.679	2.390
Alosa pesudoharengus	2431		1,198.54	485.04	1.606	3.543	0.792	0.706
Anchoa mitchilli	886		436.82	176.78	0.631	1.392	0.311	0.278
Anguilla rostrata	3		1.48	0.60	0.117	0.258	0.057	0.052
Brevoortia tyrannus	4113		2,027.81	820.64	25.055	55.278	12.353	11.019
Cynoscion regalis	8		3.94	1.60	0.036	0.079	0.018	0.016
Dorosoma cepedianum	300		147.91	59.86	0.145	0.320	0.072	0.064
Fundulus diaphanus	5		2.47	1.00	0.012	0.027	0.006	0.005
Fundulus heteroclitus	2		0.99	0.40	0.007	0.015	0.004	0.003
Hybognathus nuchalis	64		31.55	12.77	0.400	0.883	0.197	0.176
Ictalurus catus	25		12.36	4.99	0.285	0.629	0.141	0.125
Ictalurus punctatus	8		3.94	1.60	0.254	0.560	0.125	0.112
Leiostomus xanthurus	4		1.97	0.80	0.073	0.161	0.036	0.032
Membras martinica	3		1.48	0.60	0.006	0.013	0.003	0.003
Menidia beryllina	321		158.26	64.05	0.459	1.013	0.226	0.202
Menidia menidia	29		14.30	5.79	0.037	0.082	0.018	0.016

Table 43. Summary estimates for 1982 Juvenile Recruitment Survey (Cont'd).

	NUMERICAL				WEIGHT			
Species	Sample Size	Total Area Swept (hectare)	Mean No./ hectare	Mean No./ acre	Kg.	lb.	Kg. per hectare	lb. per hectare
Morone americana	23	2.0283	11.34	4.59	0.878	1.937	0.433	0.386
Morone saxatilis	6		2.96	1.20	0.447	0.986	0.220	0.197
Notemigonus crysoleucas	7		3.45	1.40	0.203	0.448	0.100	0.089
Notropis hudsonius	25		12.33	4.99	0.179	0.395	0.088	0.079
Pomatomus saltatrix	2		0.99	0.40	0.120	0.265	0.059	0.053
Trinectes maculatus	5		2.47	1.00	0.013	0.029	0.006	0.006
Morone sp. (hybrid bass)	1		0.49	0.20	0.002	0.004	0.001	0.001
TOTALS	12922	2.0283	6,369.90	2578.29	36.399	80.306	17.945	16.007

the alosids, especially blueback herring, preferred shallow water areas for nursery grounds. Burbidge (1974) also found that juvenile blueback herring were concentrated in surface waters in the James River, Virginia.

According to a study by Conte et al, (1980) on day/night trawling effort in the upper Chesapeake Bay, bay anchovy was the only species sampled that exhibited offshore migration at night. Maximum catches of this species was taken at the six meter contour during the nighttime. Catch percentage at the six meter contour was greater at night, whereas catch percentage at the two meter contour was greater during the day. The total catch in most night series of sampling suggests that the majority of bay anchovy migrate farther offshore than the six meter contour at night. This pattern of apparent offshore migration could help explain why this plankton-feeding species was so readily caught during the nighttime with the push trawl in the Patuxent River. According to this study, maximum catches of Atlantic menhaden were taken primarily at the four and six meter contours. There was greater differences in percentage of catch during the nighttime as compared to the day catches on all sampling dates. Significantly larger fish were taken onshore for all transects compared. A significant percentage of this species was also taken in the mid-water and surface locations at these contours. The apparent density pattern of this species within the nursery area could help explain the large catches with the push trawl during the three year study in the Patuxent River.

Alosa pseudoharengus:

Alewife herring were taken on all sampling dates and were more widely distributed than juvenile blueback herring. Night catches totalled 2,501 fish, of which 978 (39%) were taken in September 1982 (Figure 58). This was probably due to greater reproductive success during this year and also the fact that in September juveniles become more concentrated downriver as a first stage of their seaward migration (Loesch and Kriete, 1980).

Lowest numerical abundance totalled 206 in numbers (94.87/hectare) in the sampling sites located below Lyons Creek, whereas the highest abundance, totalling 2,205 in numbers (1,015.47/hectare) occurred at the sampling sites above Lyons Creek during the three year study period. This could be attributed to different salinities from both areas of the river (see discussion above). The greatest differences in percentage of catch occurred in September 1982, when the maximum salinity gradients occurred (Figure 58). Apparently, both the diel migration pattern and size distribution of juvenile alewife herring were influenced by a preference for higher salinity, which was greater for the larger individuals (55 fish, $\bar{x}$ 84 mm). Both maximum catch and mean length of alewife herring were taken in August and September during the three year period, when the maximum salinity gradients occurred. This size related response to higher salinities may also be important in the pattern of downriver migration of alewives in the late summer and early fall. Weight abundance was identical in distribution to numerical density; sampling sites downriver from Lyons Creek was lowest at .261 kg./hectare, while the highest abundance occurred at the sampling sites above Lyons Creek (1.149 kg./hectare).

Anchovy mitchilli:

Bay anchovy were taken on every sampling date. Night catches totaled 8,657 fish, of which 4,479 were taken in September for the entire study

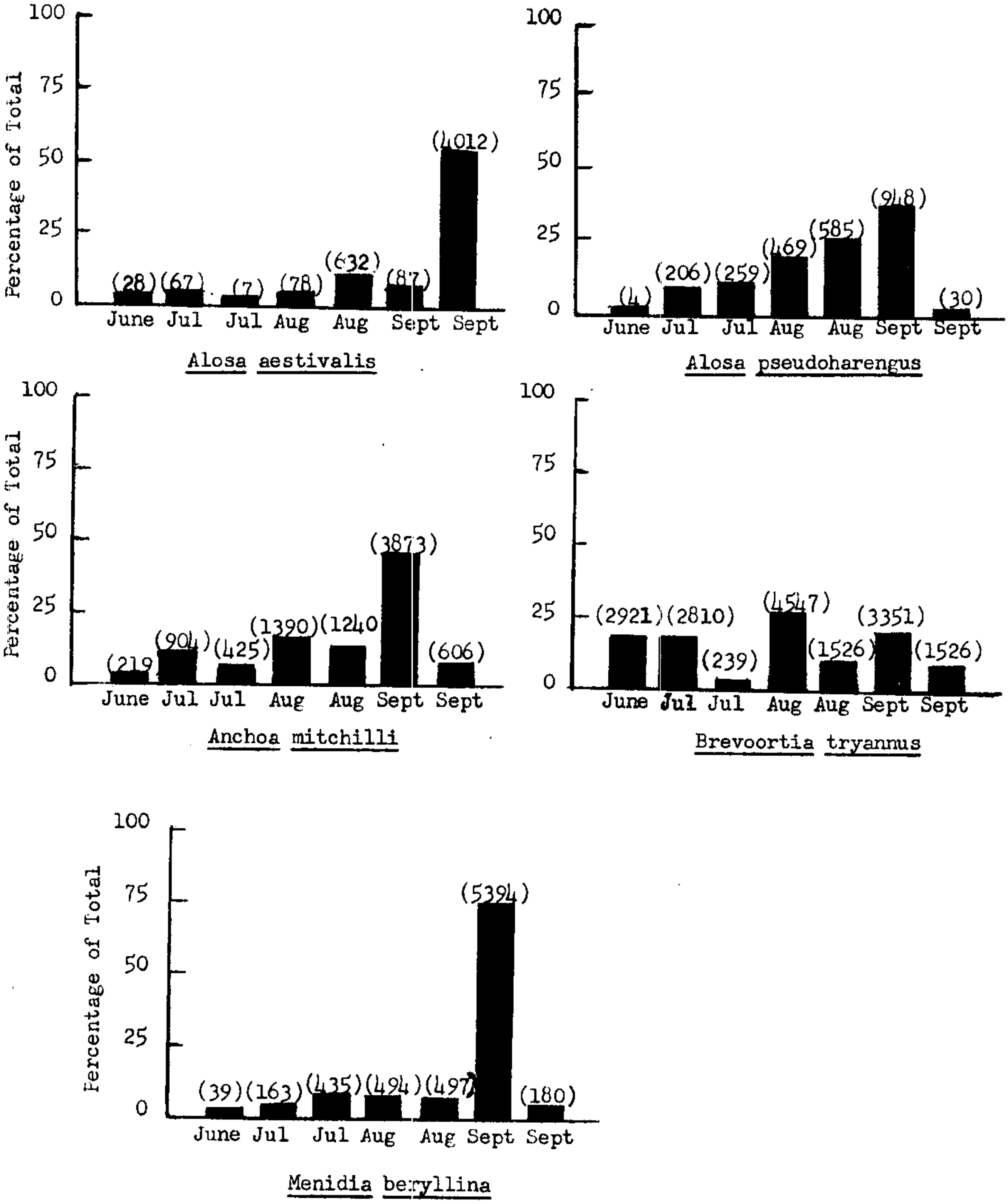


Figure 58. Percentages of total species catches for each biweekly sampling date, 1980-1982 (June sampling occurred only once). Total species catches for each date are indicated in parentheses.

period, which is over 50% of the total catch (Figure 58). Maximum catches were taken in the Patuxent River at the sampling sites located below Lyons Creek, where the highest salinities occurred. Numerical abundance below Lyons Creek totaled 7,876 in numbers (3,627.15/hectare), while the sampling sites above Lyons Creek had very low abundance, totaling 781 in numbers (359.68/hectare). Weight abundance, similarly, was highest at the sites below Lyons Creek (2.476 kg./hectare) and lowest above Lyons Creek (0.688 kg./hectare). Weight density for this species was lowest (0.030 kg./hectare) at the site located above Rt. 4 road crossing near Waysons Corner, Maryland, where salinity ranged from less than .10 to .19 ppt. for the three year period.

Brevoortia tyrannus:

Atlantic menhaden were taken on all sampling dates. Night catches totaled 16,920 fish, of which 5,819 (34%) were taken in August and September 1980 (Figure 58). This species was distributed relatively evenly throughout the sampling locations for each year. There was very little differences in percentage of catch for each sampling period (Figure 58), except the August sampling period (6,073 fish), which totaled 36% of the total catch. Maximum catches of menhaden were not affected by higher salinity gradients at the sampling sites.

During 1980 the sampling sites located in low salinity areas of the river (above Lyons Creek where salinities ranged from less than .10 to 1.10 ppt.) totaled 5,441 (2,505.76/hectare) fish as compared to 6.242 (2,874.64/hectare) fish in the higher salinity areas (below Lyons Creek where salinities ranged from .11 to 9.50 ppt.).

Overall, numerical and weight abundance were, however, much larger in the sampling sites located in the freshwater portions of the Patuxent River (above Lyons Creek). Numerical abundance was slightly greater at the sites below Lyons Creek, totaling 9,607 in numbers (4,424.34/hectare), as compared to the 8,803 fish (4,054.07/hectare) in the sampling sites above Lyons Creek. Numerical abundance was highest at the Selby Landing site, totaling 4,928 in numbers (2,269.50/hectare), which is located .9 mile upriver from Lyons Creek. The lowest numerical density was at the site located above Rt. 4 road crossing, totaling 675 in numbers (310.86/hectare). This site was expected to have the lowest density, since it is located the farthest upriver with the lowest salinity (less than .10 to .19 ppt.). Weight abundance was greater at the sites located above Lyons Creek (55.107 kg./hectare) than it was below this stream (32.626 kg./hectare). Maximum weight abundance of 50.750 kg. (23.372 kg./hectare) occurred at one site in the river where the salinity ranged from less than .10 to .90 ppt. This site was located .7 mile above the confluence of Western Branch.

Menidia beryllina:

Tidewater silversides were taken on every date sampled except for the July and September 1980 samples. Night catches totaled 7,202 fish, of which 5,394 (75%) were taken during September 1981 (Figure 58). This is attributed to the extremely large catch at the sampling site located in Western Branch, which totaled 4,171 in numbers (1,934.69/hectare) during 1981. This large catch in Western Branch could be due to the push trawl sampling the entire water column (1.5 m). The greatest differences in percentage of catch (75% of the total catch) occurred during the first sampling series in September 1981 (Figure 58). On all other sampling dates as shown in Figure 58, this species was distributed relatively even.

Lowest numerical abundance totaled 892 in numbers (410.80/hectare) in the sampling sites located below Lyons Creek, while the highest abundance, totaling 6,310 in numbers (2,905.96/hectare) were found in the sites above Lyons Creek for the three year study period. Weight abundance parallel to numerical abundance; sampling sites located downriver from Lyons Creek was lowest (0.752 kg./hectare), while the highest abundance (8.518 kg./hectare) occurred in the sampling sites located above Lyons Creek. Both the high numerical and weight densities can be attributed to the apparent salinity preference of this species for lower salinity.

In summary, sampling data suggest that these five species exhibit different diel abundance and distribution depending on their salinity preference, which appeared to be influencing the catches. Night catches were found to be greatest during September for each year, when the maximum salinity gradients occurred. Only the plankton-feeding Atlantic menhaden showed no apparent effect on its total catch by higher or lower salinity gradients in the river. Numerical densities were very similar in distribution to weight densities; sampling sites located downriver from Lyons Creek, where salinities were high, ranging from .11 to 9.50 ppt ($\bar{x}$ 1.96 ppt) had the lowest numerical and weight abundances. Sites above Lyons Creek, which had salinities ranging from less than .10 to 1.10 ppt ($\bar{x}$ .21 ppt.), had the highest numerical and weight densities for each species.

3. Growth:

The mean fork lengths of juvenile blueback and alewife herring in the Patuxent River drainage are shown in Table 44 for each month of sampling. The growth rates of the young-of-year river herring from the study area have been plotted in Figure 59. Fish from the 1981 year class were generally larger than those from the more numerous 1982 year class (see

Table 44. Mean fork length (mm) of juvenile *Alosa* species by month from the Patuxent River drainage (rounded off to the nearest mm) in 1980, 1981, and 1982.

Location and Species	June	July	August	September
Patuxent River - 1980				
Alosa aestivalis		41(54)	50(74)	57(54)
Alosa pseudoharengus	41*	62(4)	72(16)	75(5)
Patuxent River - 1981				
A. aestivalis	36(28)	42(12)	59(4)	63(34)
A. pseudoharengus	54(4)	56(6)	64(6)	78(28)
Patuxent River - 1982				
A. aestivalis		29(7)	51(632)	55(4012)
A. pseudoharengus		45(456)	56(1028)	77(947)

( ) - Sample Size
* - Data not sufficient to characterize a mean for that month (only one specimen collected).

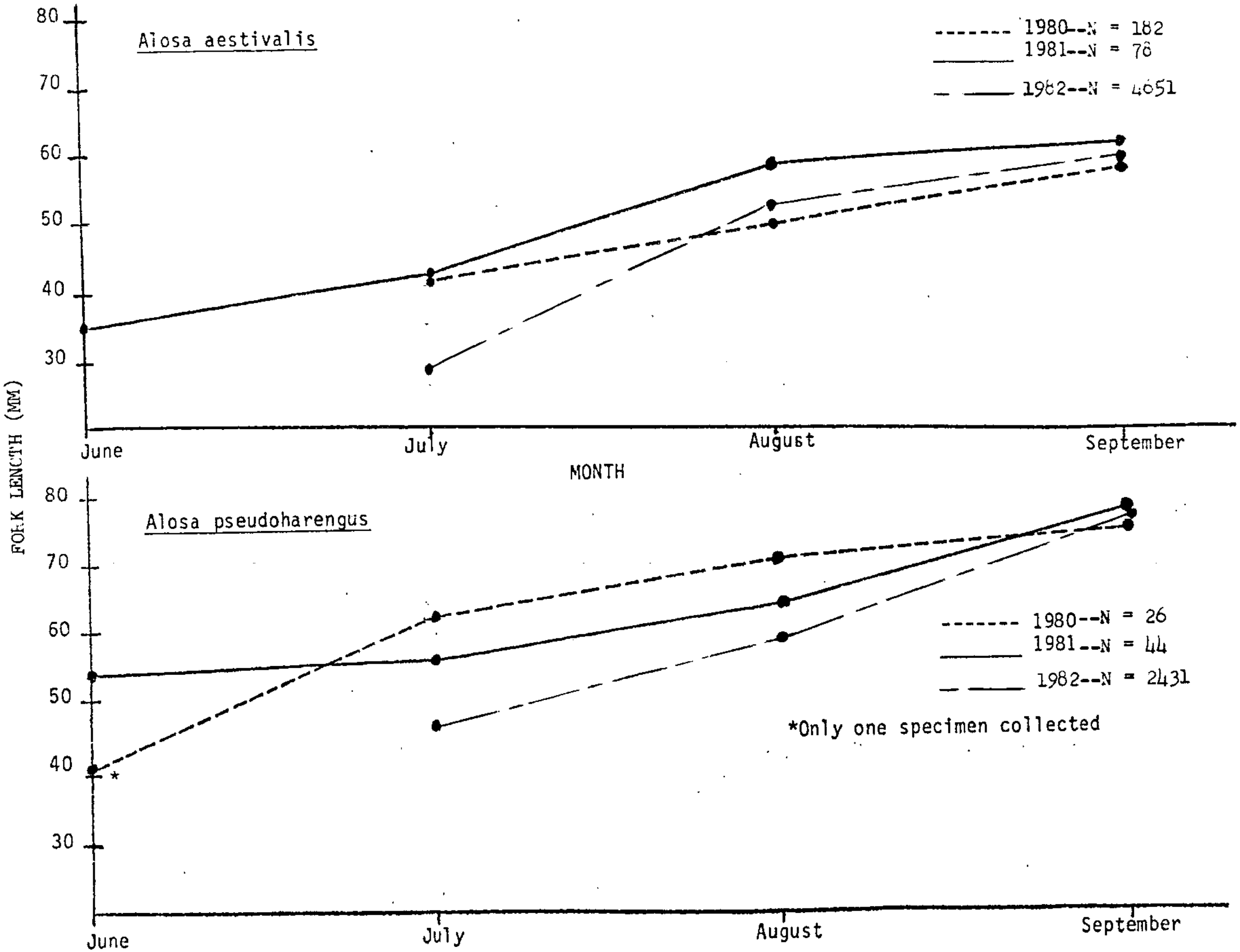


Figure 59. Mean fork-length of juvenile *Alosa* species for 1980, 1981, and 1982 year class by month (June through September), for the Patuxent River.

discussion of relative abundance above), suggesting that growth might be somewhat density-dependent as shown in Figure 59. Although the growth rates vary from year to year, blueback herring were generally much smaller than alewife herring for each month (Table 44). The only explanation that can be offered is the differences in time when the bulk of each species spawns (blueback herring usually a few weeks behind alewife herring). Alewives entered the Patuxent River several weeks earlier than bluebacks to spawn. Growth during the three year study was very similar. The higher growth rate in 1980 and 1981 may be due to the relatively small sample sizes for each year. The flatness of the growth curves can be related to juvenile movement, suggesting migration of the larger fish.

LITERATURE CITED

1. Burbidge, R. C. 1974. Distribution, growth, selective feedings, and energy transformation, of young-of-the-year blueback herring, Alosa aestivalis (Mitchill), in the James River, Virginia. Transactions of the American Fisheries Society, 103(2): 297-311.

2. Conte, M. H., R. G. Otto, P. E. Miller, Jr. 1980. Day and night distributions of juvenile fishes in the nearshore region of the upper Chesapeake Bay. Special Rep. No. 80. Chesapeake Bay Institute, The Johns Hopkins University: 5-21.

3. Havey, K. A. 1961. Restoration of anadromous alewives at Long Pond, Maine. Transactions of the American Fishery Society 90(3): 281-286.

4. Johnson, Harrel B., B. F. Holland, Jr., and Scott G. Keefe. 1977. Anadromous fisheries research program, northern coastal area. Completion Rep., Proj. AFCS-11, N.C. Div. Mar. Fish.: 4-69.

5. Kriete, W. H. and J. G. Loesch. 1980. Design and relative efficiency of a bow-mounted pushnet for sampling juvenile pelagic fishes, Transactions of the American Fishery Society 109: 649-652.

6. Loesch, J. G., W. H. Kriete, Jr., J. G. Travelstead, E. J. Foell and M. A. Hennigar. 1979. Biology and management of mid-Atlantic anadromous fishes under extended jurisdiction. Part II: Virginia Comp. Rep. 1977-1979. Nat. Mar. Fish. Serv., Proj. No. AFCS 9-1 to 9-3. Virginia Institute of Marine Science, Gloucester Point, Virginia: 204 p.

7. Loesch, J. G. and W. H. Kriete. 1980. Anadromous fisheries research program, Virginia. Annual Rep. 1980, Proj. No. AFC 10-1. Virginia Institute of Marine Science, Gloucester Point, Virginia: 66-96.

8. Loesch, J. G., W. H. Kriete, Jr. and E. J. Foell. 1982. Effects of light intensity on the catchability of juvenile anadromous Alosa species. Transactions of the American Fishery Society 111 (1): 41-44.

9. Street, Michael W., P. P. Pate, B. F. Holland Jr., and Allyn B. Powell. 1975. Anadromous fisheries research program, northern coastal region. Completion Rep. Proj. AFCS-8, N.C. Div. Mar. Fish.: 87-106.

RECOMMENDATIONS

Biological sampling to document watercourses utilized by anadromous species for spawning and nursery areas and stream surveys to inventory watercourse conditions affecting spawning have been conducted since 1968 under Projects AFC-3, AFC-8, AFC-9, and AFC-10. Many of the streams located in the 17 Maryland counties having anadromous fish spawning potential were investigated in the studies. Extensive biological sampling data to determine spawning streams was conducted on over 500 watercourses in the upper Chesapeake Bay and Western Shore river drainages. Surveys to locate and record barriers and other stream conditions were performed on streams sampled for anadromous spawners plus some additional watercourses during the studies. The following measures are, therefore, recommended to promote and improve anadromous fish (and other species) propagation and conservation in the Chesapeake Bay drainage system.

1. Natural resources management agencies of Maryland involved in fisheries management and/or environmental review of proposed watershed development projects should give priority planning consideration to projects affecting anadromous fish passage and propagation potential on identified spawning streams in the river systems of Maryland.
2. Future studies, similar to the present one, should be conducted to ascertain additional streams utilized by anadromous fish species in the Eastern Shore drainage systems of Maryland and conditions along watercourses affecting fish passage and spawning success. High priority for initial stream investigation should be given to watercourses in areas of expanding domestic populations and watershed developments where stream pollution and alterations are likely to occur.

3. On anadromous spawning streams, future study projects are recommended to assess populations of fish species blocked by stream barriers. These obstacles should be removed or mitigated to allow anadromous and other species of fish access to spawning areas, where upstream conditions are suitable for spawning.
4. Policy should be continued to prohibit or mitigate the construction of dams, raised culverts, and other stream barriers on anadromous spawning streams in order to preserve spawning areas.
5. Stream inventory data should be collected on a systematic stream and river drainage basis, using past study methods and procedures. Collected information on anadromous fish spawning species, stream barriers and other data collected in the Anadromous Fish Stream Survey Project should be disseminated to management agencies for utilization in environmental review, thereby preventing potential losses of spawning habitat.
6. Some problem situations that are documented along watercourses, including pollution discharges and stream alterations, are unknown to responsible management agencies. The systematic written referral of stream problem conditions in violation of Maryland's Natural Resources laws and regulations should be continued to bring about improvements in conditions for aquatic life.
7. Planting anadromous fish stocks (of eggs and/or fish) in watercourses devoid of anadromous spawners or having low populations of these species may be a feasible means of establishing and/or improving fish propagation potential of streams.

8. Although there is extensive documentation on the spawning behavior and life cycles of river herring (alewife and/or blueback) in various watersheds along the northeastern United States, there are only limited reports for the Maryland portion of the Chesapeake Bay. Continuation of studies, similar to the past one, should be conducted to characterize the structure of adult spawning populations of alewife and blueback herring. Future studies are recommended to contribute to the life histories of each herring species by aging to determine the age composition and spawning history of each respective spawning population, growth rates, sex ratios, and percentage of first and repeat spawners. Completion of these studies will contribute significantly to a data base needed for rational management alternatives and catch allocations at the state level.

Recommendations one, two, four, five, and six have been implemented and will be continued during the course of anadromous fish survey and inventory in the Eastern Shore river drainages of Maryland.

In view of the dramatic decline of all anadromous fish populations in the Chesapeake Bay since 1970, especially with the closure of the commercial shad fishery in 1980, recommendations three and seven need to be implemented in an attempt to increase spawning habitat (#3) and population levels (#7) of anadromous species in the Chesapeake Bay drainage.

Appendix A. River tributaries sampled in the Patuxent River study area and anadromous species documented by Project AFC-10, 1980-83 1/.

Streams Sampled 1/	Station No.	Stream Mile	Stream Character	Type of Sampling	Salinity 2/ Range (ppt)	Herring 4/	Alewife	Blueback Herring	Striped Bass	Shad	White Perch	Yellow Perch
						Anadromous Species Collected 3/						
Battle Creek	1	3.9	Fluvial	Plankton/Trap	.10L-.10L							
Black Swamp Creek	1	0.6	Tidal	Plankton	.10L-2.20				Xe			
	2	1.3	Tidal	Plankton	.10L-.10				Xe		Xe,l	
	3	3.0	Fluvial	Plankton/Trap	.10L-.10L							
Charles Branch	1	0.2	Tidal	Plankton	.10L-.17	Xe			Xe		Xe,l	
	2	2.7	Fluvial	Plankton/Trap	.10-.12							Yl
	3	3.7	Fluvial	Plankton/Trap	.10-.12							
Chew Creek	1	0.8	Tidal	Plankton	.10L-3.60						Xe	
	2	1.8	Tidal	Plankton	.10L-.12						Xe	
Cocktown Creek	1	0.6	Tidal	Plankton	.10L-2.00						Xe,l	
	2	1.3	Tidal	Plankton	.10L-.20	Xe					Xe,l	Yl
	3	3.3	Fluvial	Plankton/Trap	.10L-.10							
Collington Branch	1	0.2	Fluvial	Plankton/Trap	.10L-.12	Xe					Xe,l	
	2	1.5	Fluvial	Plankton/Trap	.10L-.11						Xe	
Cuckold Creek	1	3.3	Fluvial	Plankton/Trap	.10L-.10L							

Appendix A. River tributaries sampled in the Patuxent River study area and anadromous species documented by Project AFC-10, 1980-83 1/ (Continued).

Streams Sampled 1/	Station No.	Stream Mile	Stream Character	Type of Sampling	Salinity 2/ Range (ppt)	Herring 4/	Alewife	Blueback Herring	Striped Bass	Shad	White Perch	Yellow Perch
						Anadromous Species Collected 3/						
Davidsonville Branch	1	0.2	Fluvial	Plankton/Trap	.10L-.11							
Ferry Branch	1	0.7	Fluvial	Plankton/Trap	.10L-.10							
Friday Creek	1	0.2	Tidal	Plankton	.10L-1.00						Ye,1	Y1
Graham Creek	1	0.0	Tidal	Plankton/Trap	.10L-.34				Xe		Xa,e,1	Xa
Green Branch	1	0.3	Fluvial	Plankton/Trap	.10L-.11							
Hall Creek	1	1.6	Tidal	Plankton	.10-.80	Xe,1			Xe,1		Xe,1	X1
	2	2.5	Tidal	Plankton	.10-.37	X1			Xe		Xe,1	X1
Hellen Creek	1	2.0	Tidal	Plankton/Trap	.10L-1.00							
Mataponi Creek	1	0.5	Tidal	Plankton	.10L-.16	Xe,1					Ye,1	Y1
Midway Branch	1	0.0	Fluvial	Plankton/Trap	.10-.14	Xe,1		Xa				
	2	0.6	Fluvial	Plankton/Trap	.10-.16							
Mill Branch	1	0.1	Fluvial	Plankton/Trap	.10L-.10	Xe						
	2	1.3	Fluvial	Plankton/Trap	.10L-.10							
Mill Creek (trib. to Patuxent R.)	1	3.3	Fluvial	Plankton/Trap	.10L-.10L						Xa	Xa
Mill Creek (trib. to Hunting Creek)	1	0.5	Tidal	Plankton	.10L-.34						Xe	X1

Appendix A. River tributaries sampled in the Patuxent River study area and anadromous species documented by Project AFC-10, 1980-83 1/ (Continued).

Streams Sampled 1/	Station No.	Stream Mile	Stream Character	Type of Sampling	Salinity 2/ Range (ppt)	Herring 4/	Alewife	Blueback Herring	Striped Bass	Shad	White Perch	Yellow Perch
						Anadromous Species Collected 3/						
Mt. Nebo Branch	1	0.1	Fluvial	Plankton/Trap	.10-.16	Xe,1					Xe,1	
Persimmon Creek	1	1.2	Fluvial	Plankton/Trap	.10L-.10L							
Quakers Swamp	1	0.4	Tidal	Plankton/Trap	.10L-.10						Ya	
Rock Branch	1	0.2	Fluvial	Plankton/Trap	.10L-.10	Xe					Ya	
	2	1.5	Fluvial	Plankton/Trap	.10L-.10L							
Ropers Branch	1	0.1	Fluvial	Plankton	.10L-.10							
Sewell Branch	1	2.1	Fluvial	Plankton/Trap	.10L-.10							
Spice Creek	1	0.4	Tidal	Plankton	.10L-.48	X1			Xe,1		Xe,1	X1
St. Leonard Creek	1	5.4	Fluvial	Plankton/Trap	.10L-.10L							
Stocketts Run	1	0.8	Fluvial	Plankton/Trap	.10L-.10							
Swanson Creek	1	1.7	Tidal	Plankton	.20-6.50						X1	
	2	2.9	Tidal	Plankton	.10L-.28						X1	
	3	4.5	Fluvial	Plankton/Trap	.10L-.10L							
Towsers Branch	1	0.0	Fluvial	Plankton/Trap	.10L-.10	Xe					Xa	
	2	0.5	Fluvial	Plankton/Trap	.10L-.10							

Appendix A. River tributaries sampled in the Patuxent River study area and anadromous species documented by Project AFC-10, 1980-83 1/ (Continued).

Streams Sampled 1/	Station No.	Stream Mile	Stream Character	Type of Sampling	Salinity 2/ Range (ppt)	Herring 4/	Alewife	Blueback Herring	Striped Bass	Shad	White Perch	Yellow Perch
						Anadromous Species Collected 3/						
Horsepen Branch	1	0.0	Fluvial	Plankton/Trap	.10L-.10						Xa	
Hotchkins Branch	1	0.8	Tidal	Plankton	.11-.48	X1			Xe		Xe,1	X1
Hunting Creek	1	1.6	Tidal	Plankton	.10-6.50	X1					X1	X1
	2	3.4	Tidal	Plankton	.10L-.34							X1
	3	4.6	Tidal	Plankton	.10L-.28						X1	X1
	4	6.0	Fluvial	Plankton/Trap	.10L-.10L						Xa	Xa
	5	6.1	Fluvial	Plankton/Trap	.10L-.10L							
Johns Creek	1	1.7	Fluvial	Plankton/Trap	.24-.40							
Killpeck Creek	1	2.3	Fluvial	Plankton/Trap	.10L-.10							
Kings Branch	1	0.1	Fluvial	Plankton/Trap	.10L-.10						Xa	
	2	1.4	Fluvial	Plankton/Trap	.10L-.10L							
Little Lyons Creek	1	0.5	Tidal	Plankton	.28-7.50							X1
Little Patuxent R.	1	0.0	Fluvial	Plankton/Trap	.10L-.12						Xa,e	Xa
	2	3.2	Fluvial	Plankton/Trap	.10L-.12	Xe		Xa			Xa	
	3	5.5	Fluvial	Plankton/Trap	.10L-.12	X1					Xa,e	

Appendix A. River tributaries sampled in the Patuxent River study area and anadromous species documented by Project AFC-10, 1980-83 1/ (Continued).

Streams Sampled 1/	Station No.	Stream Mile	Stream Character	Type of Sampling	Salinity 2/ Range (ppt)	Herring 4/	Alewife	Blueback Herring	Striped Bass	Shad	White Perch	Yellow Perch
						Anadromous Species Collected 3/						
	4	6.8	Fluvial	Plankton/Trap	.10L-.12	Xe,l	Xa				Xa,e	
	5	10.2	Fluvial	Plankton/Trap	.10L-.12						Xa	
	6	11.6	Fluvial	Plankton/Trap	.10L-.12	Xe,l		Xa			Xa	
Lyons Creek	1	0.5	Tidal	Plankton	.10L-.14	Xe,l					Xe,l	Xl
	2	1.1	Tidal	Plankton	.10L-.16	Xl					Xe,l	Xl
	3	2.5	Fluvial	Plankton/Trap	.10L-.11						Xa,e	
	4	4.6	Fluvial	Plankton/Trap	.10L-.10							Xl
Walker Branch	1	0.2	Fluvial	Plankton/Trap	.10L-.10L							
Western Branch	1	1.0	Tidal	Plankton	.10L-.16	Xe,l					Xe,l	Xl
	2	3.5	Fluvial	Plankton/Trap	.11-.16	Xe					Xa,e,l	
	3	7.4	Fluvial	Plankton/Trap	.10-.16						Xa,e,l	
White Marsh Branch	1	0.6	Fluvial	Plankton/Trap	.10L-.10L							
Wilson Owens Branch	1	0.5	Fluvial	Plankton/Trap	.10L-.10							Xl
(890,900E-378,100N) Unnamed Stream	1	0.5	Fluvial	Plankton/Trap	.10L-.11							

Appendix A. River tributaries sampled in the Patuxent River study area and anadromous species documented by Project AFC-10, 1980-83 1/ (Continued).

Streams Sampled 1/	Station No.	Stream Mile	Stream Character	Type of Sampling	Salinity 2/ Range (ppt)	Herring 4/	Alewife	Blueback Herring	Striped Bass	Shad	White Perch	Yellow Perch
						Anadromous Species Collected 3/						
(892,400E-391,800N) Unnamed Stream(ZBF)	1	0.1	Fluvial	Plankton	.10L-.10							
(890,200E-298,400N) Unnamed Stream(ZBN)	1	0.0	Fluvial	Plankton	.10L-.10							
(888,800E-400,800N) Unnamed Stream(ZBR)	1	0.0	Fluvial	Plankton/Trap	.10L-.10L							
(887,500E-404,100N) Unnamed Stream(UFN)	1	1.3	Fluvial	Plankton/Trap	.10L-.10							
(887,200E-407,600N) Unnamed Stream(ZBS)	1	0.1	Fluvial	Plankton	.10L-.10							
(885,400E-412,300N) Unnamed Stream(ZBT)	1	0.5	Fluvial	Plankton/Trap	.10L-.12							
(884,200E-420,500N) Unnamed Stream(ZBV)	1	0.1	Fluvial	Plankton	.10L-.10							
(883,800E-424,800N) Unnamed Stream(ZCD)	1	0.3	Fluvial	Plankton/Trap	.10L-.10							
	2	0.7	Fluvial	Plankton	.10L-.10							
(865,200E-457,200N) Unnamed Stream(ZBU)	1	0.2	Fluvial	Plankton	.10L-.10							

Appendix A. River tributaries sampled in the Patuxent River study area and anadromous species documented by Project AFC-10, 1980-83 1/ (Continued).

Streams Sampled 1/	Station No.	Stream Mile	Stream Character	Type of Sampling	Salinity 2/ Range (ppt)	Anadromous Species Collected 3/: Herring 4/	Alewife	Blueback Herring	Striped Bass	Shad	White Perch	Yellow Perch
(881,400E-423,000N) Unnamed Stream(UDK)	1	0.5	Fluvial	Plankton/Trap	.10L-.12							
(867,400E-437,800N) Unnamed Stream(UPG)	1	1.1	Fluvial	Plankton/Trap	.10L-.10L							
(845,900E-451,100N) Unnamed Stream(ZBW)	1	0.0	Fluvial	Plankton/Trap	.10L-.10							
(845,500E-454,100N) Unnamed Stream(ZCC)	1	0.6	Fluvial	Plankton/Trap	.10L-.24							
(847,400E-456,100N) Unnamed Stream(ZCA)	1	0.5	Fluvial	Plankton/Trap	.10L-.42							
Total No. of Streams Sampled: 58			No. of Spawning Streams by Species:			16	1	2	6	0	24	16

Total No. of Sites Sampled: 89

1/ Includes all river tributaries sampled during the AFC-10 study (1980-83) (See Appendix B for sampling and spawning in the river mainstem)
2/ L = less than (.10L = less than .10 ppt salinity)
3/ Xa = adults collected
Xe = eggs collected
Xl = larvae collected
4/ Egg/larval documentation only (alewife or blueback identification uncertain)

Appendix B. Sites sampled in the Patuxent River mainstem and anadromous species documented by Project AFC-10, 1980-83 1/.

Stations Sampled 1/	River Mile	Stream Character	Type of Sampling	Salinity 2/ Range (ppt)	Herring 4/	Alewife	Blueback Herring	Striped Bass	Shad	White Perch	Yellow Perch
					Anadromous Species Collected 3/						
			AFC 10-3, 1983 Study								
1	23.0	Tidal	Plankton	3.2-11.0				Xe		Xl	
2	25.2	Tidal	Plankton	1.0-7.0	Xl			Xe			Xl
3	27.2	Tidal	Plankton	.20-7.0							Xl
4	29.4	Tidal	Plankton	.10-3.8				Xe		Xl	Xl
5	31.7	Tidal	Plankton	.10L-3.2	Xl			Xe		Xl	Xl
6	34.0	Tidal	Plankton	.10L-3.2	Xl			Xe		Xl	Xl
			AFC 10-2, 1982 Study								
7	37.2	Tidal	Plankton	.12-1.4	Xl			Xe,l		Xe,l	Xl
8	42.2	Tidal	Plankton	.11-.30	Xl			Xe		Xe,l	Xl
9	45.1	Tidal	Plankton	.10-.19	Xl			Xe		Xe,l	Xl
10	48.5	Tidal	Plankton	.10-.14	Xl					Xe,l	Xl
11	52.2	Tidal	Plankton	.10L-.14	Xe,l					Xe,l	Xl
12	55.5	Fluvial	Plankton/Trap	.10-.16	Xe,l	Xa	Xa			Xa,e,l	Xa,e,l

Appendix B. Sites sampled in the Patuxent River mainstem and anadromous species documented by Project AFC-10, 1980-83 1/ (Continued).

Stations Sampled 1/	River Mile	Stream Character	Type of Sampling	Salinity 2/ Range (ppt)	Herring 4/	Alewife	Blueback Herring	Striped Bass	Shad	White Perch	Yellow Perch
			AFC 10-1, 1980 Study		Anadromous Species Collected 3/						
13	56.6	Fluvial	Plankton/Trap	.10L-.12	Xe,l					Xa,e	Ya
14	61.2	Fluvial	Plankton/Trap	.10L-.10						Xa	Ya
15	64.5	Fluvial	Plankton/Trap	.10L-.11						Xa	Ya
16	67.2	Fluvial	Plankton/Trap	.10L-.10L	Xe					Xa,e,l	
17	72.2	Fluvial	Plankton/Trap	.10L-.10L						Ya	
18	76.3	Fluvial	Plankton/Trap	.10L-.10L							
19	78.8	Fluvial	Plankton/Trap	.10L-.10	Xe						
20	80.3	Fluvial	Plankton/Trap	.10L-.10L							Xa,l
21	81.5	Fluvial	Plankton/Trap	.10L-.10L							Xl
			No. of spawning sites by species:		12	1	1	8	0	15	16

1/ Includes all sites sampled during the AFC-10 study in the Patuxent River mainstem (See Appendix A for sampling and spawning in river tributaries)
2/ L=less than (.10L=less than .10 ppt salinity)
3/ Xa = adults collected
Xe = eggs collected
Xl = larvae collected
4/ Egg/larval documentation only (alewife or blueback identification uncertain)

GEN 84-0033 4321
Survey and Inventory of
Anadromous Fish Spawning
Streams...Patuxent River